Before the Independent Hearing Panel
Appointed by the Southland Regional Council

Under	the Resource Management Act 1991 (**RMA**)
In the matter of	an application by **South Port NZ Limited** to dredge parts of the Bluff Harbour

Statement of evidence of James Stewart

29 March 2022

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Qualifications and experience

1 My name is James Alistair Stewart.

2 I am currently employed by GeoSolve Limited, a geotechnical and civil engineering consultancy firm and based in our Cromwell Office.

3 I am an Otago trained geologist with 10 years working experience including 6 years as an engineering geologist across Otago, Southland, Fiordland, and the West Coast. There I have been involved with geotechnical fieldwork for residential, commercial and infrastructure projects including building and subdivision developments, treatment plants, pipelines, wharfs, irrigation dams, quarries, and mines across a variety of geological terranes.

4 I have experience in construction related geotechnical investigation and assessment including geological ground modelling, slope stability assessment, rock defect mapping and modelling, fault mapping, groundwater modelling, landslides, and natural hazard assessment with extensive local knowledge of the geological conditions across Otago/Southland. I also have a strong background in resource-based geology including exploration, quarrying, and mining. I hold a Bachelor of Science in geology and a post graduate diploma in geology from the University of Otago.

5 I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2014. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Scope of evidence

6 I have been asked to prepare evidence on the prevailing geotechnical ground conditions within the Bluff Harbour entrance channel in relation to the application by South Port to undertake drilling, blasting, and dredging operations. I prepared the Geotechnical Assessment for the Proposal and adopt this as part of my evidence. My evidence includes:

(a) The wider geological setting of Bluff Harbour;

(b) Geology and geotechnical conditions specific to the entrance channel i.e.:

(i) South-western side of channel; and

(ii) North-eastern side of channel.

(c) Slope stability review of proposed rock cuts; and

(d) Geotechnical considerations and recommendations for drilling, blasting, and dredging operations within the entrance channel.

Geological setting of Bluff Harbour

7 Bluff Harbour is underlain by basement rocks of the Bluff Intrusive Complex and metasedimentary Greenhills Group. These basement rocks are in turn unconformably overlain by the Gore Lignite Measures comprising sandstone, siltstone, conglomerate, carbonaceous mudstone, and lignite coal seams. More recent floodplain deposits of Holocene age comprising unconsolidated sand, gravel, and mud as well as beach dunes also overlie basement rocks. These recent sediments are being actively deposited within Bluff Harbour and will be dredged as part of the proposed activity.

8 No active fault traces are recorded within the vicinity of Bluff Harbour, and none were observed during field mapping. Strong ground shaking throughout the South Island is likely to be associated with a rupture of the Alpine Fault, located approximately 240 km to the northwest along the West Coast of the South Island.

Entrance channel geology and geotechnical conditions

9 The entrance channel to Bluff Harbour is underlain by bedrock of the Greenhills Group and is bordered to the southwest by the Bluff Intrusive Complex. Two separate rock types of the Greenhills Group outcrop on the foreshores either side of the channel. Foreshore exposures on the south-western and north-eastern sides comprise hornfels facies schists and quartz-keratophyre bedrock respectively (refer Appendix A, Figures 1a-1c attached). These two rock types bound the floor and immediate sides of the channel and comprise the host rocks in which proposed cuts will be made by drilling, blasting, and dredging. The contact between the separate rock types presumably trends in a similar direction to the channel. Previous information collected by divers indicates that rock types on the channel floor are the same as those outcropping on either foreshore.

South-western side of channel (refer Appendix A, Figure 1b)

10 The southwestern foreshore comprises a series of strongly banded (closely spaced) un-weathered to slightly weathered hornfels facies schists. The banded hornfels strike northwest roughly parallel with the beach front and dip steeply between 62-85˚ towards the northeast or reversely towards the southwest. The foliated bands intersect the side wall of the channel at low angles somewhere between 14 and 28˚. The layered northwest striking

bands are the primary and most obvious defect planes within the hornfels. Less pervasive secondary joint defects strike north-south perpendicular to the primary layering. These secondary joint defects intersect each other at high angles facilitating blocks to weather out in triangular slabs. The hornfels schists are a product of contact metamorphism during intrusion of the Bluff Intrusive Complex.

North-eastern side of channel (refer Appendix A, Figure 1c)

11 The northeastern foreshore comprises un-weathered to slightly weathered quartz-keratophyre bedrock. Other rock types of the Greenhills Group bound the keratophyre on its north-eastern edge and are staggered across Tiwai Peninsula. However, the proceeding rock types beyond the keratophyre are outside the influence of proposed cuts arising from drilling, blasting, and dredging. The keratophyre is heavily dissected with joint defects, most of which are orientated in three planes and intersect each other at right angles. The interaction of these joint sets allows the rock to be broken out in roughly rectangular blocks. Defects at the surface of both rock types range from closed to open but are expected to become increasingly tight with increasing depth.

Slope stability review of proposed rock cuts

12 The mapped foreshore exposures are strong to very strong and generally un-weathered or occasionally slightly weathered. Defects within both rock types either side of the channel are pervasive and will extend to depth well beyond the proposed cuts resulting from drilling, blasting, and dredging.

13 Any slope instability will be governed by the strength and orientation of defects relative to cut faces rather than overall rock mass strength. Owing to the extent and orientation of defects the rock either side of the channel tends to weather out in distinct blocks or slabs. The same can therefore be expected during the blasting and dredging of bedrock within the channel. Blasting and excavation is more likely to break the rock out along preferential failure surfaces (foliation and joints) rather than through the rock mass. The potential for large scale instability or failure along a consistent length of cut face is considered unlikely. For this to occur a laterally continuous steeply dipping defect of low shear strength would need to become exposed on the proposed excavated faces. This scenario is made more unlikely owing to the variability of cut heights (refer example cross-sections attached).

Geotechnical considerations and recommendations for drilling, blasting, and dredging operations within the entrance channel

14 If required, it may be possible to trim the cut faces back to a shallower angle from sub-vertical by preparing a staggered blasting sequence along the edges of the channel. Following blasting of the cut faces, dredging can take place top to bottom, according to the blast depth, to achieve a shallower batter therefore improving slope stability. This would only be necessary for cut heights ranging from 2.5-3.5 m. Dredging and cutting on the south-western side of the channel will be more readily achieved if the dredge were to work from the southeast towards the northwest by cutting backwards on an oblique angle to the banded hornfels (refer Appendix A, Figure 1b).

15 Effects of vibration and noise caused by blasting operations on the adjacent dwellings and infrastructure of Bluff Township has been considered by Jon Styles.

16 GeoSolve recommends further site inspections during blasting and dredging operations and review of the pre/post works underwater video survey footage to confirm bedrock conditions are in accordance with our geotechnical report.

Summary of key issues I worked on and my conclusions

17 The key issue my geotechnical report is intended to address is the potential for instability of rock cuts on either side of the channel arising from drilling, blasting, and dredging operations. Our geotechnical report confirms that ground conditions within the harbour entrance channel are not conducive to produce large scale or destructive whole mass rock failures with respect to the proposed activity. Long-term, it is more conceivable that cut faces will fret and erode individual blocks with tidal action, seismic shaking, and the passing wakes of ships. The excavation of seamounts on the channel floor bounded by free faces will not cause any notable slope stability issues as they will leave behind a planated surface on the sea floor (refer example cross-sections attached).

Response to any issues in section 42A report

18 In general, the 42A report summarises and concurs with my geotechnical assessment for the proposed work. The key issue raised by the 42A report is the limited amount of site-specific data on rock strength either side of the channel. However, in this instance the orientation and concentration of defects within the rock mass will govern slope stability, not the rock strength. We have tried several times to undertake unconfined compressive strength (UCS) testing on lengths of rock core from drill holes in Bluff

Harbour for this project and others, but the rock has persistently sheared along pre-existing defects (refer UCS test results by CTS attached). Owing to the pervasive nature of defects within the rock mass obtaining lengths of rock core free of defects suitable for UCS testing is difficult. OCEL who also have prior experience with the rock types in Bluff Harbour state that the UCS of a rock fragment they collected was more than 80 MPa and could be as high as 100 MPa consistent with my findings. Considering the relatively low heights of the proposed rock cuts, the rock defects will govern slope stability in this case.

19 As noted in the 42A report, I also believe any geological uncertainties will be discovered during the proposed drilling and blasting trials and can be worked through on an on-going basis through the course of the work programme. Other than the issue discussed above there are no other notable issues raised with respect to my geotechnical assessment.

Response to matters raised in submissions

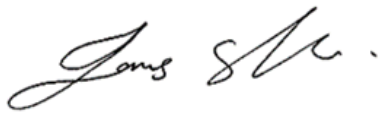
20 We understand that eleven submissions were received following public notification of the application on Saturday 11 December 2021. Two submissions from the Department of Conservation and Forest and Bird were in opposition and nine in support.

21 The key issues raised by those submissions in opposition are unrelated to the geotechnical ground conditions within the entrance channel and my scope of evidence.

Conclusion

22 Considering the relatively low heights of proposed rock cuts resulting from drilling, blasting, and dredging operations the application is considered technically feasible from a geotechnical perspective. Provided the effects of vibration and noise caused by blasting operations is addressed, no notable geotechnical issues are expected to arise from the application.

Evidence prepared by:



James Stewart
Engineering Geologist
GeoSolve Ltd

29 March 2022

Attachments:

- Appendix A, Figures 1a-1c;
- Appendix B, Example cross-sections; and,
- Appendix C, UCS test results by CTS.